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New or Noteworthy Records of Canadian Odonata

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Since the publication of Whitehouse's Catalogue of the Odonata of Canada and Alaska (1) several papers on Canadian Odonata have appeared that have added to our knowledge of the composition and distribution of this order of insects in Canada. Two species have been added to the Canadian list, viz., *Celithemis martha* Wmsn. from Nova Scotia by Cook (2) and *Somatochlora sahlbergi* Trybom from the Mackenzie District, N.W.T., by Walker (3). Cook adds also the following that are new to Nova Scotia: *Enallagma cyathigerum* Charp., *Gomphus spicatus* Hagen, *G. ventricosus* Walsh, *Celithemis elisa* Hagen, *Libellula pulchella* Drury, *L. lydia* Drury and *L. luctuosa* Burm.; and one new to New Brunswick, *Aeshna interrupta interrupta* Walk.[1] Walker (3) adds two to Labrador (*Lestes disjunctus* Selys and *Libellula quadrimaculata* L.), two to Manitoba (*Somatochlora septentrionalis* Hagen and *Leucorrhinia patricia* Walk.) and four to the Mackenzie District, N.W.T. (*Lestes congener* Hagen, *Nehallenia irene* Hagen, *Somatochlora albicincta* Burm. and *Sympetrum obtrusum* Hagen) besides *Somatochlora sahlbergi*, already mentioned. He also gives a list of 14 species from the Yukon Territory, from which only two species were previously known .

The following notes are not restricted to records new to provinces or territories but include any occurrences of species that seem worthy of note.

Lestes eurinus Say

Among the morainic hills and depressions that lie a few miles east of Snelgrove, Peel Co., Ont., there is one large, shallow pond in an open pasture, which we have often visited. It is frequented by cattle and is richly fertilized by their droppings. As a result the insect population is large, including many predators, such as Corixidae, Notonectidae, Dytiscidae and Odonata. The Odonata are not very numerous in species but are often very abundant in individuals. In some seasons there is a considerable growth of emergent vegetation, in others it is entirely absent in the spring and there are not enough weed stalks to support the nymphs of all the emerging dragonflies. In years of extreme drought this pond sometimes dries up.

On May 28, 1944, we visited the pond and found only three dead stalks projecting above the surface of the water, all of them thickly covered with exuviae, chiefly of *Enallagma boreale*. About a dozen newly emerged *Lestes eurinus* were found, mostly in the water, where they had fallen from the overcrowded stalks, and were either drowned or had one or more wings crippled. One nymph had just emerged upon a stalk and transformed on the return trip in a box into which we had placed it.

We revisited the pond on June 3rd. Five tenerals of *L. eurinus* were taken from the littoral zone of short rushes or near the water. Two had emerged within fifteen to twenty minutes, the others somewhat earlier. An exuvia was also found among the small rushes.

The same pond was visited in the spring of 1945 and repeatedly since then

[1]The record is from Sackville, which is in New Brunswick, not Nova Scotia.

without our finding a trace of *L. eurinus* in any stage. But on May 27, 1951, we found it again, although in a different pond. I was dredging nymphs from a ditch surrounding a tamarack swamp a few hundred yards south of the first pond mentioned, while my wife went off on a little exploratory trip of her own. Climbing the hilly pasture to the immediate south of the swamp, she discovered a hollow scarcely a hundred yards away with a pond at the bottom of it that we had never seen before, although we have visited the swamp for many years. This pond, like the other, lies in an open pasture. It is much smaller in area but has more definite banks upon which dragonflies can transform, and a patch of cat-tails (*Typha*) growing in the water near one end. *Enallagma boreale* and *Gomphus furcifer* Hagen were both emerging in large numbers and the water's edge was strewn with exuviae of the latter. Tenerals of *Leucorrhinia intacta* Hagen and *Libellula lydia* Drury were also frequent. But the main event was the re-discovery of *Lestes eurinus*. We first found a nymph that had climbed up a rush to emerge, and within the next fifteen minutes we had found a newly emerged female and a fine series of nymphs, all of which were ready for emergence within a day or two.

Our next trip to Snelgrove was on June 11, but *Lestes eurinus* had fled; neither nymphs nor adults could be found. On June 17, in the late afternoon, we visited the pond once more. At first we were disappointed. We walked more than halfway around the pond before any *L. eurinus* were seen. But when we reached the first small group of cat-tails I captured a male upon one of them. Soon after the male I had a female, and at the main patch of cat-tails I caught two pairs in tandem and saw others that were out of reach. It is probable that the individuals that emerged were well dispersed, as there are many ponds in this vicinity. Judging from the fact that those seen at this pond were all concentrated in the small patch of *Typha*, it is not surprising that no adults remained about the first pond, where they emerged in 1944, since there were no cat-tails or other tall emergent plants there.

We have one more record of this species to report. A full grown nymph was taken by Mr. A. G. Edmunds, on or about July 15, 1949, from a bog lake in Sproule twp., Algonquin Park, Ontario. This is the northern limit of its range in Ontario, so far as known.

Amphiagrion saucium Burm.

Near Bucklaw, Cape Breton Island, Nova Scotia, August 11, 1948, 3 ♂ and 2 ♀ were taken among the sedges and rushes growing in a springy spot of wet sand, which drained into a running brook a few yards away. This is a new record for the Maritime Provinces, although it was expected here.

Coenagrion interrogatum Hagen

Among a number of dragonflies taken by Mr. E. L. Bousfield, on July 3, 1951, from a gravel pit three miles south of Nelson, New Brunswick, there are two specimens, ♂ and ♀, of this boreal species. The record is new not only for New Brunswick but also for the Maritime Provinces.

C. interrogatum has been shown (3) to be distributed farther northward than the previous records indicated, but we have also two Ontario records which are taken from localities considerably farther south of its hitherto known range. These are Smoke Lake, Algonquin Park, where I took a female on July 12, 1942, and Bella Lake, near Huntsville, Muskoka District, July 13, 1944. The Smoke Lake specimen was taken from a sheltered expansion of a small stream, near its mouth, where the banks, though marshy, were not typical of its bog habitat. The Bella Lake specimens, 2 ♂, were found about a pond surrounded by a true

quaking bog, with its characteristic flora, such as the pitcher plant, sundews, *Pogonia*, *Calopogon*, etc., and the surrounding belt of black spruce and tamarack. This is the typical habitat of *C. interrogatum* in its southernmost stations and it seems always to be a denizen of bogs and cold northern swamps. The paucity of individuals at this particular bog was doubtless due to the lateness of the season.

Enallagma cyathigerum Charp.

This species was not listed from the Maritime Provinces in either of my two papers on the dragonflies of this region, (4, 5). On August 5, 1948, I took a male from the marshy bank of a pond about fifteen miles north of Ste. Anne, C.B., Nova Scotia, but it has since been recorded by Cook (2) from Waverly and Mt. Uniacke, N.S. We can now fill another gap in the Canadian part of its range with a record from New Brunswick, as we have recently examined two males, taken by Mr. E. L. Bousfield on July 3, 1951, from a gravel pit three miles south of Nelson, N.B.

Some of the Ontario records of this species (6) belong to *E. vernale* Gloyd, a species which had not been recognized at the time when the Ontario list was prepared. The following are the localities in Ontario, with counties or districts, from which *E. cyathigerum* has been correctly reported: Port Arthur, Gull River and Silver Islet, Thunder Bay District; Smoky Falls, Cochrane District; Favourable Lake and Attawapiskat Lake, Patricia section of the Kenora District. McDunnough (7) recorded it from the Lake of Bays, Muskoka District, but I have not examined his specimens. Our record from Horning's Mills is also uncertain.

Since the Ontario list appeared we have taken *E. cyathigerum* at De Grassi Point, Simcoe County, and at Terra Cotta, Peel County. The previous record from De Grassi Point belonged to *E. vernale* but on July 5, 1947, 2 ♂ of *E. cyathigerum* were taken at a temporary pond in a gravel pit, which is usually too small for anything but *Lestes unguiculatus*. In 1947, however, it was greatly enlarged by heavy spring rains and attracted many species of dragonflies, including two species that had not been seen in the vicinity of De Grassi Point in over forty years. One of these was *Celithemis elisa*, the other *Enallagma cyathigerum*.

In the vicinity of Terra Cotta we have taken this species at or near a quarry pond on the side of the escarpment, not far from the foot. This is a permanent pond through which a small stream flows and, although small, is the breeding place of a number of dragonflies. We have taken *E. cyathigerum* here on several occasions, viz., June 16, 1946 (4 ♂); July 26, 1947 (1 ♂) and June 5, 1949 (1 ♂). July 26 is a very late date for this species, yet it was a teneral that was found on this occasion. Individuals of many species of dragonflies, however, emerge occasionally at unusual seasons, early or late. Terra Cotta is the most southerly locality in Ontario where *E. cyathigerum* has been taken, but it is considerably higher than De Grassi Point, which appears to be south of the breeding range in that part of Ontario.

Enallagma vernale Gloyd

This species, described by Mrs. Gloyd in 1943 (8), was not distinguished from *E. cyathigerum* at the time my Ontario list (6) was prepared. But, having obtained a paratype from Mrs. Gloyd, I soon discovered that both species were present in Ontario and that nearly all the more southern records attributed to *cyathigerum* belonged to *vernale*. The following localities listed under the former refer to *E. vernale* (the dates are added): Long Point, Norfolk County, June 10, 1927; Toronto Island, York County, June 30, 1914; De Grassi Point, Simcoe County, June 27, 1918, and June 13, 1942; Glen Island, Picton, Prince

Edward County, June 24, 1925; Sand Hills, Prince Edward County, June 19, 1936; Gananoque, Leeds County, June 21, 1936, and Go Home Bay, Muskoka District, June 21, 1907. It has also been recorded from Sioux Lookout and Malachi in the Kenora District (9) and I took a male near Snelgrove, Peel County, Ontario, on June 12, 1943.

It may be noted here that the nymph which I described in 1916 (10) as that of *E. cyathigerum* proved to belong to *E. vernale* when this species became known to me.

On June 12, 1948, my wife and I set forth on a short trip by motor-car with the main object of finding *E. vernale* again. Since the Toronto station where this species was once common has now been destroyed as a habitat for Odonata, we drove eastward along Lake Ontario and the headwaters of the St. Lawrence, stopping first at Gananoque. On June 13, skirting the shore of the St. Lawrence east of the town for a distance of about eight miles, we came to a marshy bay where there were myriads of Enallagmas. Most of them were *E. ebrium* but there were occasional individuals that appeared to be slightly larger or more robust and of a paler blue colour. These proved to be males of *E. vernale*. We took only six of these and found no females at this station. We then drove westward into Prince Edward County, and, on the following day, we visited many shallow marshy ponds in the sandy terrain near East Lake. *E. vernale* was not rare here but difficult to spot among the hosts of *E. ebrium*. We had not yet recognized the female but presently took a pair in cop. and soon had two more females. We could now recognize it easily by the very narrow humeral stripe and the larger pale areas of the abdominal pattern, as compared with *E. ebrium* and *hageni*.

On June 14 we were due to return to Toronto, but, when our time was nearly up, we obtained a good series of males, though no more females, along the edge of a wooded ravine, at the bottom of which was a channel of deeper and colder water than that of the shallow ponds. Although these males of *vernale* were flying in the open sandy area along the edge of the wood, high above the channel, it was probably from this channel that *E. vernale* had emerged, not from the ponds. But the lack of time prevented us from verifying this point.

Ophiogomphus mainensis Packard

Several nymphs were collected by Mr. E. L. Bousfield on the Miramichi River, New Brunswick, as follows: Little Southwest Miramichi River, September 2, 1950, 1 nymph, about penultimate stage; same, rapids, 1 full grown, 1 penultimate stage and 1 very young; Northwest Miramichi, rapids, July 10, 1951, 1 antepenult. stage.

This is a new record for New Brunswick and the Maritimes, although it was expected here. It is not always safe to determine species of *Ophiogomphus* from the nymph, but in *O. mainensis* the third segment of the antenna has a characteristic and unmistakable form.

Ophiogomphus asperdus Morse

A single male was taken in a large sphagnum bog five or six miles north of Port Hastings, Cape Breton Island, Nova Scotia, on August 11, 1948. It had doubtless strayed there from some stream in the vicinity.

This species has been recorded from New Brunswick but not before from Nova Scotia.

Lanthus parvulus Selys

This species was found at a small woodland brook, where it crossed the highway near Bucklaw, Cape Breton Island, Nova Scotia. Males were resting on

boulders in the rapids and flew actively on approach. A fair series of males was taken but no females were seen.

The tpe locality of *L. parvulus* is "Nova Scotia" but this is the first record from a definite locality in the Province.

Cordulegaster obliquus Say

In the summer of 1946 I was one of a party of naturalists who were spending a fortnight on Franklin Island, Georgian Bay, in the Parry Sound District, Ontario. On July 9 we crossed the channel to the mainland on a general natural history hike. The terrain here is typical of the Canadian Shield, and most of it has been burned over more or less recently, so that there are considerable areas of bare rock.

We soon crossed a small stream, typical of the region, a brook with many rapids and pools and, for the most part, well shaded in this part of its course. Almost immediately I caught sight of a *Cordulegaster* patrolling the stream. I missed it twice as it made the usual long flight up and down the stream. Finally I captured it and, to my amazement, I recognized it as my first specimen of *C. obliquus*, a male. Not wishing to hold up the party, I reluctantly moved on but in a few minutes was rewarded by a second male, which was captured after it came to rest on the twig of a dead tree.

This locality is the most northerly one from which *C. obliquus* has been recorded.

Aeshna eremita Scudder

Although one of the most widely distributed dragonflies in Canada, there has been hitherto no record of this species from New Brunswick. A male was taken by Mr. E. L. Bousfield at a gravel pit three miles south of Nelson, New Brunswick, on July 3, 1951.

Aeshna i. interrupta Walk.

This species, recorded by Cook (2) from Sackville, was found by Mr. Bousfield at South Nelson, N.B., two males having been captured at a gravel pit pond on Aug. 21, 1951.

Aeshna palmata Hagen

In the afternoon and evening of August 3, 1949, we had the opportunity of collecting dragonflies for a short time in the Cypress Hills Provincial Park, Saskatchewan. The only species of special interest observed was *Aeshna palmata* Hagen, which we found in the afternoon patrolling the margins of the lake in front of the Lodge, and, in the evening, hawking in a clearing in the lodgepole pine forest, beside the road.

This is the first time this species has been observed in Canada, east of the Rocky Mountains, and the record is thus new for Saskatchewan. It is certainly an isolated population, as the species does not occur in the prairies, being decidedly a denizen of the mountains. It is abundant in Canada from the Pacific coast to the Alberta Rockies and ranges northward into Alaska. The altitude of the Cypress Hills is not much below that of Banff and their forests have an aspect very like those of the Rockies owing to the abundance of the Lodgepole Pine, but whether there is any correlation between the presence of these two inhabitants of the Rockies in this isolated area, we do not know.

Perithemis tenera Say

This small libellulid, which is abundant south of the Canadian border, has been recorded hitherto from two Canadian localities only, both in Essex County, Ontario. Since these records were published the following have come to our notice: Pelee Island, Essex County, July 7, 1950, 1 ♀ (Virginia Kohler); Dolson

Creek, Oxley, Essex County, July 9, 1950, 3 ♂ (E.M.W.); Chesney Lake, Innerkip, Oxford County, July 13, 1947, 2 ♂ (W. Miles); Princess Point, Dundas Marsh, Wentworth County, August 14, 1946, 2 ♂ (E. Turner).

These records indicate that *P. tenera* is to be found locally throughout the Carolinian Zone in Ontario, but is limited to this zone. It is not to be expected from any other part of Canada.

Libellula vibrans Fab.

A mature male was taken at Point Pelee, Essex County, on June 21, 1951, by Eric Thorn of the Royal Ontario Museum of Zoology.

This is the first report of this southern species from Canada.

Sympetrum pallipes Hagen

This western species has hitherto been known in Canada only from British Columbia, but we captured a female at Suffield, Alberta, on August 2, 1949. It was taken with the next species and *S. internum* Montg. about a dry ditch along a prairie road. I have also identified a specimen, now destroyed, from Crooked Creek, Waterton Lakes Park, Alberta, taken by D. R. Foskett on July 18, 1937.

Sympetrum occidentale fasciatum Walk.

This dragonfly, referred to in Whitehouse's Catalogue (1) as *S. semicinctum occidentale* Bart., was found at Suffield, Alberta, on August 2, 1949, 3 ♂ and 2 ♀ having been taken. They were flying over the ditches along a prairie road in company with *S. internum*. Probably the ditches contained water earlier in the season.

The subspecies *occidentale* Bart. has recently been elevated to specific rank by Walker (11) and divided into three subspecies, of which *fasciatum* is the most eastern, inhabiting th semi-arid plains and foothills of the Rocky Mountains. It is typically distinguishable by the dark transverse bands bordering the amber-coloured bases of the wings. These bands were very noticeable during flight in the case of the Alberta specimens, giving them an aspect quite different from the eastern *S. semicinctum*.

This is the first record of *S. occidentale* from Alberta and the first of the subspecies *fasciatum* from Canada. The form found in British Columbia is *S. O. occidentale* Bart.

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Factors Influencing the Specific Gravity of Insect Haemolymph[1]

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Introduction

The physiochemical properties of the blood of an animal are maintained in a close equilibrium conducive to the normal functioning of the organism. Disturbances in the physiological function may result in characteristic changes in the blood. For example, the specific gravity of normal human blood, which averages about 1.060, may vary with age, sex, nutritive condition, and disease (Hawk, Oser, and Summerson, 1947). The reaction of blood to metabolic and pathological conditions is recognized by the medical profession as a valuable aid in diagnosis (Scudder, 1939). Changes have been shown in the specific gravity of human blood in pregnancy and cancer (Polowe, 1932; 1934). It has also been shown that haemorrhage is accompanied by a decline in the specific gravity (Richet, Brodin, and Saint-Girons, 1918).

In work on the bass *Huro salmoides* (Lacépède), Abegg (1947) found a difference in the blood density of fish taken from Mississippi River water and those held in tap water. The individuals held in tap water refused to eat. The author concluded that there was a correlation between the blood density and the physiological condition of fish.

The specfiic gravity of the blood, or haemolymph, of insects has received little attention in entomological literature. Among the earlier workers to investigate the specific gravity of insect haemolymph were Yeager and Fay (1935). They showed that in the cockroach *Periplaneta americana* (L.) there were significant differences between the specific gravities of haemolymph drawn from nymphs and from adults, but not between those of haemolymph taken from males and from females. On the other hand, Patton and Lin (unpublished), using the same insect, found not only that the densities of haemolymph obtained from nymphs and from adults differed, but also that there were differences between those of males and of females. The differences were highly significant. Patton (unpublished) was probably the first to note that the density of the haemolymph of larvae of *Galleria mellonella* L. changed when the insect was poisoned with certain insecticides, and this phenomenon was successfully used by Patton and Lin (loc. cit.) in a quantitative determination of dosage mortality relationships. They showed further that insects with an initially high haemolymph density were generally more susceptible to poisoning than those with an initially low density. Their data have significant implications in the mode of elimination of toxic materials and on the process of poisoning. Recently, Beard (1949) showed, with larvae of the Japanese beetle, *Popillia japonica* Newm., that induced haemorrhage results in a depression of the specific gravity of the haemolymph.

The effects of additional factors on the specific gravity of insect haemolymph have been studied at the Belleville laboratory. It is the purpose of this paper to present observations showing that feeding on desiccated foliage, parasitization, and high temperatures can alter significantly the specific gravity of insect haemolymph.

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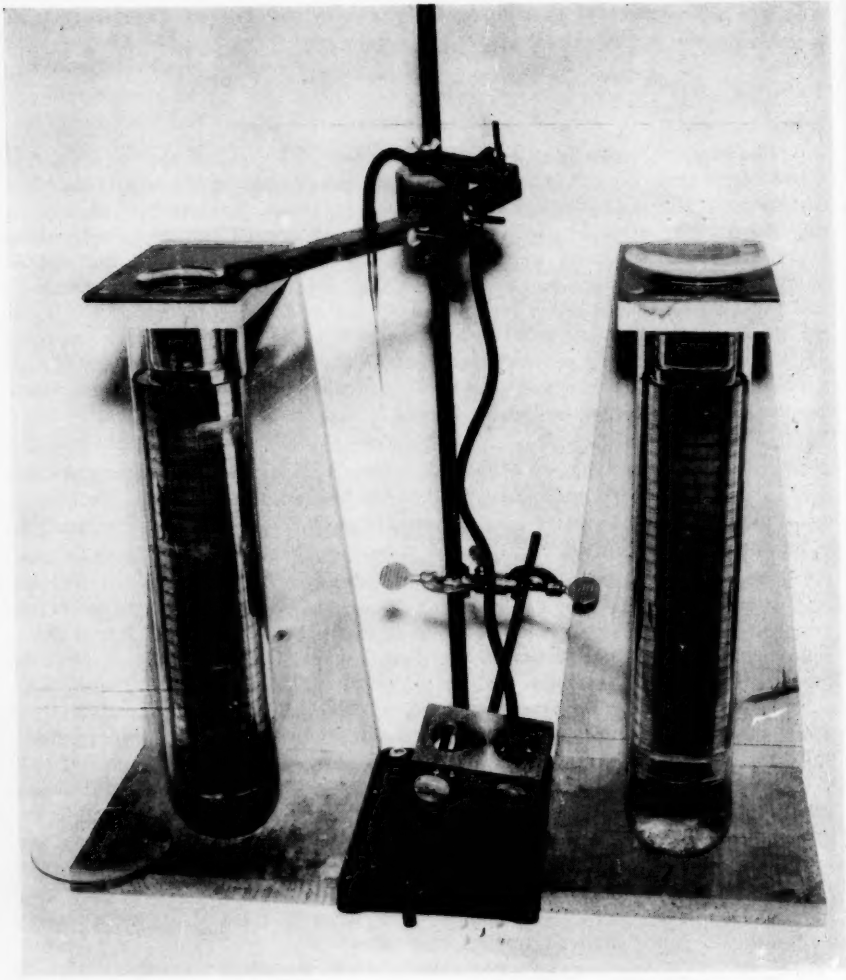

FIG. 1. Densiogradient tubes with micropipette and pipette control.

Determining Specific Gravity

Determinations of specific gravity of haemolymph were made using the technique developed by Lowry and Hunter (1945). Their micro-method, involving the use of a densiogradient, was considered particularly adaptable to the measurement of the specific gravity of haemolymph. The apparatus is shown in Fig. 1. It consisted of two densiogradient columns and a device for holding and manipulating a micropipette. The insects were punctured between the first thoracic legs with a fine glass needle. A gentle pressure applied to the body forced a tiny droplet of haemolymph to exude from the wound. The droplet of haemolymph was picked up by touching it to the tip of the pipette. The tip of the pipette was then held below the surface of the liquid in the densiogradient column by means of the manipulating device, and the droplet of

haemolymph was released by turning the thumb-screw. The pipette control consisted of a length of latex rubber tubing connected to the micropipette, which was compressed between a pair of rollers operated with a thumb-screw. Droplets of uniform size were readily obtained by this method.

In practice it was found necessary to allow a short time to elapse for the droplets to come to rest in the gradient. An interval of five minutes, therefore, was allowed to pass before the positions of the droplets suspended in the densio-gradient column were read.

Effects of Wilted Foliage

The literature indicates that the specific gravities of blood and haemolymph are variable and that the variability is due to a number of factors. Early in the present work a wide variation was noted in the specific gravities of haemolymph obtained from different groups of larvae of *Neodiprion lecontei* (Fitch) feeding on pine foliage. It appeared that the condition of the foliage was causing much of the variation. In view of this, the specific gravities of haemolymph of 25 larvae obtained directly from infested trees was compared with those of 24 larvae, in the same stage of development, reared for several days on cut and wilted foliage. It was found that the mean specific gravity of the former was $1.0378 \pm .0049$ and of the latter $1.0467 \pm .0072$. The difference was statistically significant ($P < .01$). The moisture content of the foliage or food upon which sawfly larvae feed is therefore shown to be a factor that can affect the specific gravity of the haemolymph. Consequently, care was taken to ensure that all samples of feeding larvae were given comparable food.

Effects of Parasitization

Other workers have shown that the specific gravity of blood or haemolymph is affected by the physiological condition of the animal. The following series of tests were conducted to determine whether parasitization might have an effect on insect haemolymph. One endoparasitic species, *Drino bohemica* Mesnil, and one ectoparasite, *Dahlbominus fuscipennis* (Zett.), were used.

The parasites were reared on hosts commonly employed in the Belleville laboratory. A sample of 100 overwintering larvae of *N. lecontei* were removed from their cocoons and parasitized with the tachinid *D. bohemica*. A control group of unparasitized larvae was handled in a similar manner. On the third day samples of haemolymph drawn from the two groups were tested to determine their respective specific gravities.

Similarly, other studies were carried out with *N. lecontei* larvae in the last feeding instar parasitized by *D. bohemica* and with overwintering larvae of *Neodiprion sertifer* (Geoff.), parasitized by the chalcid *D. fuscipennis*. Determinations were made on different groups of *N. sertifer* larvae parasitized for three and five days. The results are summarized in Table I.

Table I shows that the specific gravity of the haemolymph was increased in overwintering larvae of the sawfly *N. sertifer* and in both overwintering and feeding larvae of *N. lecontei*. The differences between the parasitized and the control samples were statistically significant ($P < .01$).

An attempt was made to determine whether the increment in specific gravity was accompanied by changes in the cellular characteristics of the haemolymph. Haemolymph was drawn from parasitized and unparasitized larvae of *N. lecontei* on the third day of the experiment. Smears of the haemolymph were fixed on slides in corrosive sublimate-alcohol and stained in Giemsa's blood stain. Microscopic examination of the smears showed that haemolymph from both parasitized

TABLE I.

EFFECTS OF PARASITIZATION ON SPECIFIC GRAVITIES OF HAEMOLYMPH FROM TWO SPECIES OF INSECT HOSTS

Host	Parasite	No. of Individuals		Mean haemolymph density		P value of difference between means
		Control	Parasitized	Control	Parasitized hosts	
Neodiprion lecontei (Fitch) (overwintering larvae)	*Drino bohemica* Mes.	100	100	1.0545 ± .0049	1.0566 ± .0053	< .01
Neodiprion lecontei (Fitch) (feeding larvae)	" "	49	50	1.0384 ± .0060	1.0467 ± .0073	< .01
N. sertifer (Geoff.) (overwintering larvae)	*Dahlbominus fuscipennis* (Zett.)	44	26	1.0540 ± .0038	1.0584 ± .0050 (at 3 days)	< .01
N. sertifer (Geoff.) (overwintering larvae)	" " "	44	36	1.0540 ± .0038	1.0555 ± .0041 (at 5 days)	< .01

and unparasitized larvae contained great numbers of round cells, ovoid cells, and a few spindle-shaped cells. Careful comparison of a number of haemolymph smears did not reveal any consistent differences in the shape, size, or relative number of each type of cells found in the two groups. On the other hand, a comparison of haemolymph cell counts, using the technique employed by Tauber and Yeager (1934), showed a considerable difference in the total number of cells between the two groups. The mean cell count based on results from 25 unparasitized feeding larvae was 285,800 ± 82,900 cells per cubic millimeter of haemolymph, and from 24 parasitized larvae the mean was 194,400 ± 95,000 cells. The difference between the two values was statistically significant ($P<.01$).

Empirical tests were made to determine whether the increase in specific gravity of haemolymph drawn from parasitized larvae was caused by debris resulting from the feeding actions of the parasite. Haemolymph was drawn from larvae and the specific gravity was determined. The addition of macerated body tissue to comparable samples of haemolymph did not result in any significant change. Hence, the presence of debris in the haemolymph does not appear to be an important factor.

Further investigation showed that the pH of the haemolymph was 6.97 ± .20 in unparasitized larvae of *N. lecontei*. The value for parasitized samples was 7.00±.15, which did not differ signicantly from the controls. Parasitization apparently does not affect the pH of the haemolymph.

Effects of High Temperature

The effects of high temperatures on the specific gravity of insect haemolymph have not, apparently, been investigated. The insects used in the present study consisted of overwintering larvae of the two sawfly species *N. sertifer* and *N. lecontei*. The larvae, removed from cold storage and immediately dissected from the cocoons, were exposed to heat in glass vials immersed in a water bath main-

tained at a constant temperature of 45°C. A stream of air brought as close to saturation as possible and heated to 45°C. was circulated at the rate of 100 ml. per minute through the tubes during the experiments. As shown in Table II, the groups of larvae were exposed to these conditions for periods of 15, 30, 60, 90, and 180 minutes. Subsequent observations showed that these exposures would not cause death. Untreated larvae of each species were tested as controls. Determinations of specific gravities of haemolymph were made as soon as possible after the larvae were removed from the bath. The results are summarized in Table II and Fig. 2.

TABLE II

MEAN SPECIFIC GRAVITIES OF THE HAEMOLYMPH OF LARVAE OF TWO SPECIES OF SAWFLIES EXPOSED TO 45°C. FOR VARIOUS PERIODS

Species	No.	Exposure time minutes	Mean specific gravity
Neodiprion sertifer	44	0	1.0540 ± .0038
	47	15	1.0541 ± .0059
	43	30	1.0548 ± .0053
	43	60	1.0567 ± .0043
	47	90	1.0561 ± .0015
	47	180	1.0568 ± .0040
Neodiprion lecontei	100	0	1.0545 ± .0049
	49	15	1.0567 ± .0031
	47	30	1.0577 ± .0056
	48	60	1.0599 ± .0061
	47	90	1.0590 ± .0022
	48	180	1.0598 ± .0016

These results show that high temperature caused a definite increase in the specific gravity of haemolymph. Under the experimental conditions imposed on the insects, the specific gravity increased rapidly during the first 60 minutes. For exposed specimens the maximum increase was .0053 for *N. lecontei* and for *N. sertifer* .0028. These changes are highly significant ($P<.01$) in both species.

Specific Gravity Values for Various Species

The specific gravities of the haemolymph of several species of insects have been determined. The literature on this subject was reviewed and summarized by Rapp (1947). According to Rapp the specific gravity for larvae of the honey bee, *Apis mellifera* L., is 1.045; for *Dytiscus marginalis* L., 1.025 to 1.027; for *Hydrophilus piceus* L., 1.012; for the southern armyworm, *Prodenia eridania* (Cram.), 1.032; and for *Periplaneta americana* (L.), 1.0163.

In the present work the specific gravities of the haemolymph of several additional species were determined (Table III). Only a small number of individuals of some species were available for tests and hence the determinations may

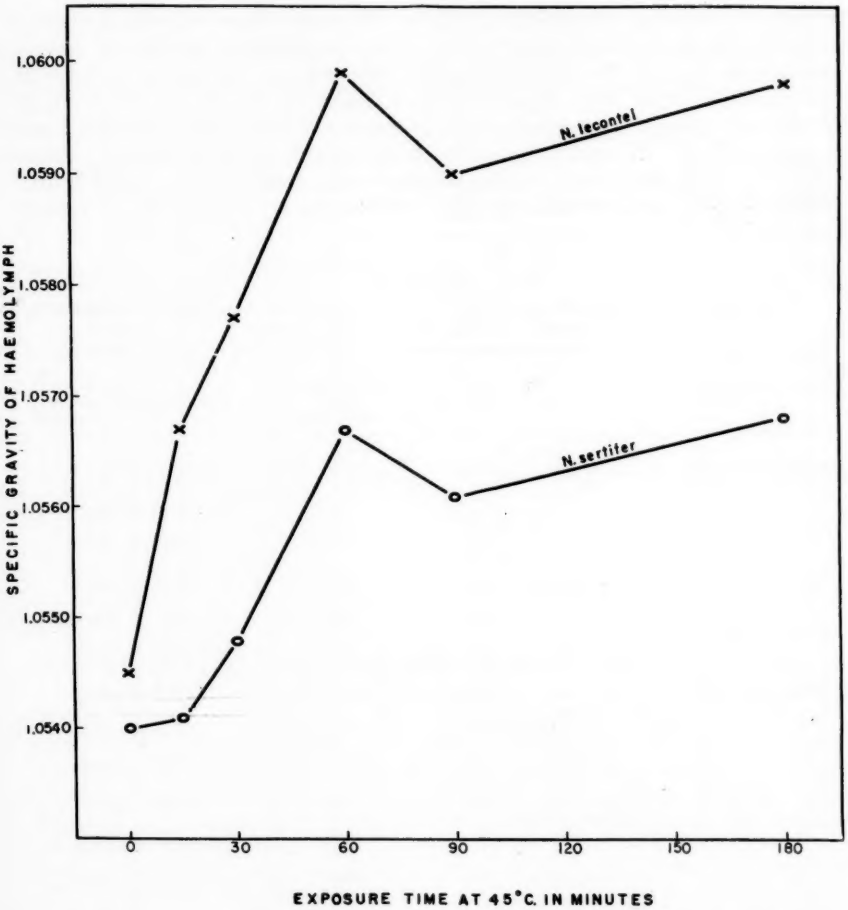

FIG. 2. Curves showing increases in specific gravities of haemolymph of *Neodiprion sertifer* and of *N. lecontei* held at 45°C for various periods.

not be reliable. However, the results of the specific gravity detreminations for all insects studied are recorded, since they may be useful as a guide for future investigators.

Discussion

It has been shown in these studies that feeding on desiccated food, parasitization, and high temperature each increase the specific gravity of sawfly haemolymph. Differences in the mean densities of treated and untreated samples were in all instances significant, indicating that specific gravity of haemolymph may be useful as a criterion of physiological change in insects.

The work has shown that the haemolymph of larvae reared on dry, wilted foliage is more dense than that of larvae reared on fresh foliage. These results indicate that diet can alter the physiological state and is a factor to be considered in evaluating the physiological response of an insect.

TABLE III

SPECIFIC GRAVITIES OF HAEMOLYMPH OF SEVERAL SPECIES OF INSECTS.

Species	No. of determinations	Mean specific gravities of haemolymph	Remarks
Neodiprion lecontei (Fitch)	49	1.0384 ± .0060	Last feeding stage
" " "	10	1.0545 ± .0081	Newly "spun-up" larvae
" " "	100	1.0545 ± .0049	Larvae from cocoons stored for one month at 1°C.
" " "	100	1.0551 ± .0052	Larvae from cocoons stored for two months at 1°C.
Neodiprion sertifer (Geoff.)	50	1.0494 ± .0080	Last feeding stage
" " "	44	1.0540 ± .0035	Larvae from cocoons stored at 1°C.
Pieris rapae (L.)	5	1.0274 ± .0025	Mature larvae
Apis mellifera L.	1	1.0740	Capped drone larva
" "	5	1.0450	Uncapped worker larvae
Loxostege sticticalis (L.)	46	1.0389 ± .0069	Mature larvae, feeding
Pyrausta nubilalis (Hbn.)	25	>1.0796	Mature larvae, feeding
Trichoplusia ni (Hbn.)	10	1.0355 ± .0067	Mature larvae, feeding
Protoparce quinquemaculata (Haw.)	3	1.0267 ± .0014	Mature larvae

The reason for the increase in specific gravity in parasitized sawfly larvae has not been established. It was first thought that the changes might have been brought about by an increase in the number of phagocytic cells or from debris produced by the feeding activities of the parasite. Tauber and Yeager (1935, 1936) showed that high totals of haemolymph cells are associated with parasitization. In nearly every case these workers found the cell counts of insects parasitized by bacteria and thread worms to be above the range of normal counts. They suggested that the increase in total count may result from either a dehydration of the haemolymph or an increased rate of formation of haemolymph cells, or both. In the present work using insect parasites the only noticeable difference was a considerable decrease in the number of cells in the haemolymph of parasitized larvae. This study indicates that the types of cells in the two groups are similar in number and form. It seems unlikely, however, that the cellular components of haemolymph could influence the specific gravity of haemolymph as determined by the present method. This view is supported by the fact that the addition of tissue debris to the haemolymph did not alter the specific gravity. It appears, therefore, that the increase is caused by changes other than the cellular composition of haemolymph.

The work has shown that, in large samples, significant differences in the specific gravities of haemolymph are found between parasitized and unparasitized sawfly larvae. It is doubtful, however, that the technique can be used at the present time as a means of detecting the presence of parasites in small samples of host insects because of the variability between individuals.

The effects of high temperature in increasing the specific gravity of haemolymph may prove to be of even greater interest than those of parasitization. Work conducted at the Belleville laboratory shows that sawfly larvae held at 42°C. for more than one hour possess a greater tolerance to higher temperatures than untreated individuals. The increase in specific gravity may, therefore, be considered as an indication of a physiological adjustment within the larvae to changes in environmental temperature. The condition may be brought about by an increase in metabolites in the haemolymph arising from an acceleration of the metabolic rate or from a loss of water. Regardless of the cause, exposure to high temperatures produces an immediate increase in the specific gravity of the haemolymph.

An interesting feature of the curve shown in Fig. 2 is the decrease in the specific gravity of the haemolymph of each of the sawflies between 60 and 90 minutes. After this decrease the specific gravity again increased. The decrease occurred repeatedly and has been substantiated by work yet to be published. It is likely that this departure from a regular curve indicates a change in the regulatory mechanism of the larvae, probably brought about by the effects of heat shock.

Another feature concerned differences in the specific gravities of haemolymph from insects of different orders and species (Table III). In the preliminary work several species of insects were tested, and the results, as well as those reviewed by Rapp (1947), show that the specific gravity of insect haemolymph extends over a wide range. It is noteworthy, however, that the densities of haemolymph of two closely related species of sawflies are so similar, and that storage of *Neodiprion lecontei* and *N. sertifer* larvae in cocoons changes the specific gravities of the haemolymph. There were indications that the density of haemolymph differs also between instars. This was noted so frequently that care was exercised to select only individuals in the same stage of development. It was found also that the haemolymph of the worker larva of the honey bee had a specific gravity of 1.0450, which is in close agreement with that reported by Rapp (1947). A test on a single drone larva gave a much greater value, suggesting a difference correlated with sex. In the work an attempt was made to test mature larvae of the European corn borer, *Pyrausta nubilalis* (Hbn.), but the upper limit of the gradient was not sufficiently high to make this possible. As a result, only one determination was obtained and it was concluded that the specific gravity was somewhat in excess of 1.0796. In view of the results obtained by Patton and Lin, the high specific gravity of the haemolymph of the corn-borer may offer an explanation for the susceptibility of this insect to poisoning with certain insecticides.

The present work, as well as that of others, shows that a number of factors affect the specific gravity of the haemolymph, and it is clear that extreme care must be used in assessing specific gravity values. At present, the specific gravity determinations are largely of academic interest. Patton and Lin appear to be the only workers who have put them to any practical application.

Summary

The specific gravities of two species of sawfly larvae reared on wilted foliage was higher than that of larvae obtained from growing trees. Overwintering and feeding larvae of *Neodiprion lecontei* parasitized by *Drino bohemica*, and of overwintering *N. sertifer* parasitized by *Dahlbominus fuscipennis*, showed statistically significant differences from controls in haemolymph densities. Marked

differences were found in the haemolymph specific gravities of sawfly larvae exposed to 45°C. for various periods. The specific gravities of the haemolymph of several species of insects studied in this work are listed.

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New North American Muscoid Diptera[1]

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The new forms described below constitute an interesting addition to the sarcophagine fauna of several western states and one eastern. I am indebted to the collectors indicated below for the privilege of studying the material accredited to them. Types of the new species based upon Kansas University material are returned for deposit in the Snow Entomological Collections as mentioned under the descriptions; all others are retained by permission in my collection.

Archimimus, n. g.

Similar to *Emblemasoma* (type, *erro* Aldrich), but the prosternum is ordinary in size and form (not strongly widened anteriorly); epistoma distinctly shorter and wider; parafacial and cheek narrower, front less prominent, etc. Also, there are decisive genitalic differences.

Frontal bristles closely set in a regular row not strongly divergent anteriorly, one to two bristles below antennal base; outer verticals vestigial and orbitals absent in male; ocellars small but distinct, proclinate; clypeus moderately depressed; epistoma in plane of latter and much wider than long; facial ridge setose on lower two-fifths; parafacial about one-half clypeal width, with several irregular rows of fine hairs extending from upper extremity to cheek groove; antenna three-fourths length of face, third segment rather slender, hardly twice as long as second; arista long plumose on basal three-fifths or more; vibrissae stout, decussate, well above oral margin; palpus clavate, longer than short haustellum; eye bare, not quite reaching to vibrissal level; cheek about one-fourth of eye height. Thoracic chaetotaxy: acrostichal 2, 1 (all well differentiated); dorsocentral 3, 4; intraalar 2; supraalar 3 or 4; presutural 1 (inner one absent or vestigial); postalar 2; notopleural 4; humeral 3-5; sternopleural 3; scutellum with 4 lateral, 1 smaller decussate apical (lacking in female) and 1 or 2 discal pairs well behind middle of disk; postnotal slope and prosternum setose; propleuron bare. Hind coxa setose on posterior margin; male claws and pulvilli elongated, mid femur with comb. Wing rather long, extending well beyond tip of abdomen; first vein bare, third setose two-thirds the distance to small cross vein; first posterior cell open far before wing tip; costal spine vestigial. Abdomen as wide as thorax; basal segments without median marginal bristles, last two each with a marginal row; genital segments rather small, retracted.

Genotype: *Archimimus camatus*, n. sp.

Archimimus camatus, n. sp.

Male.—Front at vertex 0.16 of head width, slightly narrower before ocellar triangle and widening rapidly on lower half; parafrontal gray pollinose becoming plumbeous above middle; median vitta blackish, a little narrowed toward vertex but wider than parafrontal on entire length; antenna wholly black, arista concolorous on the thickened basal fifth, thence pale yellowish nearly to middle, the remaining portion very slender and black to tip; parafacial gray pollinose to cheek groove, latter tawny; cheek subshining in some views but with thin cinereous pollen and a vestiture of fine black hairs; palpus black; back of head wholly black-haired above middle with some pale pile about the neck and below.

Thorax gray pollinose, with three broad black dorsal vittae, middle one continuing over disk of scutellum and bordered on each side by a much narrower

[1]Contribution No. 1516, from the Department of Entomology, Texas Agricultural Experiment Station.

dark vitta before the transverse suture; lateral vitta uninterrupted at suture and extending to base of scutellum.

Legs black, subshiny; mid tibia with one long anterodorsal bristle; claws and pulvilli equal to or slightly exceeding length of last tarsal segment.

Wing hyaline; bend of fourth vein angular, bearing a long fold; apical cross veins oblique and about in same plane; calypter semitransparent, white with a slight tawny tinge; epaulet black, subcostal sclerite whitish.

Abdomen black with gray pollen in a tessellate pattern above on three basal segments, fourth wholly red, with moderately heavy pale yellow to golden pollen which extends from base to tip and is somewhat changeable with the angle of view; fifth sternite red, with a deep median excision, the well separated lobes not very prominent and practically bare.

Hypopygium wholly red, lightly dusted with pale pollen; first segment not very large, bearing a row of bristly hairs on hind margin; second segment smaller than first, clothed with fine black hairs above; forceps rather small, largely reddish, united about to middle thence divided but contiguous nearly to the rounded slightly bowed tips; accessory process about half as long as forceps, evenly tapered on apical half; penis with a very short basal segment; apical segment shining brown, moderately enlarged, the apex bearing a pair of divergent, anteriorly curved prongs; below bases of latter a membranous lobe, fringed with minute setules, extends forward and inward from either side to form a semicircular concavity, which is apparently devoid of any discernible processes; posterior clasper nearly straight, with a long bristly hair before base on anterior margin; posterior clasper slightly longer and strongly bowed forward beyond middle.

Female.—Front at vertex 0.32 of head width, gradually widening forward into facial angle; two proclinate fronto orbitals and outer verticals present; apical scutellars absent; claws and pulvilli shorter than apical tarsal segment; genitalia red, retracted within tip of abdomen, first segment with a marginal fringe of black hairs; anal orifice moderately large, ovate.

Length: 9-11 mm.

Holotype male and allotype female, Chiricahua Mts., Arizona, July 3, 1947 (A. C. Michener and R. H. Beamer) in the Snow Entomological Collections, Kansas University. Paratypes: 2 males and 1 female, same data as type and 2 females, same locality except dated July 4, 1940 (D. E. Hardy and L. J. Lipovsky).

***Archimimus sternalis* (Reinhard), new combination**

Emblemasoma sternalis Reinhard, Bul. Brk. Ent. Soc., 34, 1939, 62.

The principal differences which distinguish this species from *Emblemasoma erro* are cited in the above reference. Although closely allied, *sternalis* and *camatus* are readily separable on genitalic characters.

***Sarcophaga tetona*, n. sp.**

Male.—Front at vertex 0.25 of head width, narrowed to 0.19 of same before triangle, thence evenly diverging in the facial angle; parafrontal and parafacial pale yellowish, latter with a row of coarse hairs near eye margin below becoming finer and scattered above; frontal vitta black, a little narrowed upwards and much wider than parafrontal; orbital bristles absent; outer vertical vestigial; ocellar pair normal; frontal rows moderately divergent anteriorly, two or three bristles below antennal base; parafacial over one-half clypeal width; facial ridge bristly on lower two-fifths; vibrissa on oral margin; antenna black, third segment less than twice length of second, arista moderately plumose on basal half; palpus and proboscis black, ordinary; cheek thinly gray pollinose, black-haired, one-fourth eye height;

back of head somewhat bulged or convex, clothed with black hairs intermixed with pale ones at middle and below.

Thorax gray pollinose, with three to five dark vittae above; anterior acrostichals not developed, prescutellar pair strong; three post dorsocentrals and three sternopleurals; scutellum with three lateral bristles (the hindmost two unusually approximated), a good-sized decussate apical and one discal pair behind middle; prosternum and propleuron bare; postnotal slope setose.

Legs black; mid tibia with two anterodorsal bristles and hind tibia moderately beset with long hairs; mid femur without comb; claws and pulvilli strongly elongated.

Wing subhyaline; first vein bare, third setulose nearly halfway to small cross vein; first posterior cell open far before wing tip; costal spine vestigial; epaulet black; calypter semitransparent, white.

Abdomen black, with rather dense gray pollen in a tessellated pattern above; last two segments each with a marginal row of bristles; fifth sternite black, broadly and deeply cleft, lobes rather small and inconspicuous.

Hypopygium wholly black, moderately large; first segment lightly pollinose and with scattered black hairs above; second segment more distinctly shiny and also clothed with black hairs on entire upper surface; forceps black, straight in profile, equibroad to near apex which slopes obliquely forward from hind edge to a prolonged pointed tooth on the apical extremity of the anterior margin; penis jointed beyond middle; basal segment stoutish, deeply grooved on hind side, black near base and pale translucent apically; second segment subglobose, tapered distally to a blunt anteriorly bowed compressed tip, which is highly polished at the side before apex; on the front side at the extreme base the segment bears a short broadly rounded lobe, a pair of sharp-tipped curved hooks near middle and just beyond latter a pair of short truncate brown lobes, which diverge from bases to partially expose a very minute or delicate subapical process; accessory process somewhat reddish, rather short and broadly rounded apically; posterior clasper moderately stout, tapering to a blunt, slightly hooked tip; anterior clasper longer, directed forward from base and more strongly bowed.

Length: 13 mm. Female unknown.

Holotype: Teton Pass, Wyoming, August 2, 1947 (F. A. Cowan and M. R. Wheeler).

The species is allied to *morosa*, from which it differs in genital features, as well as the narrower front and cheek and the absence of a comb on the mid femur.

***Sarcophaga latisterna irrisoris*, n. subsp.**

Male and female.—Legs, except tarsi, wholly red in ground color, mid tibia usually with two anterodorsal bristles; palpus normally black but occasionally entirely red; epaulet red; otherwise quite similar in all particulars to *latisterna*.

Length: 8-13.5 mm.

In Aldrich's key the present form traces directly to *tarsata*, which is the only red-legged species included in group "B". But there is little likelihood of confusing these forms since they differ widely in genitalic characters, among others, as mentioned in the descriptions.

***Sarcophaga epitheca*, n. sp.**

Male.—Front at vertex 0.19 and at base of antenna 0.33 of head width; parafrontal and parafacial with yellowish satiny pollen on black ground color which becomes quite evident in the region of the vertex; frontal vitta black, wider than parafrontal on entire length; frontal rows diverging anteriorly, two or three

bristles below antennal base; outer verticals vestigial, inner pair broken off but scars indicating well developed bristles; orbitals absent; ocellars proclinate; antenna black, third segment less than twice length of second, but reaching to lower third of face; arista moderately long plumose on basal half; parafacial with a row of fine hairs on outer margin which become longer and coarser near lower eye margin; clypeus gray pollinose, epistoma short, slightly produced; vibrissae decussate, on oral margin; facial ridge haired on lower half or less; palpus black, longer than the short polished black haustellum; cheek wholly black-haired, thinly dusted with gray pollen but subshining in some views, barely one-fourth the eye height; back of head with three rows of postocular cilia, a few pale hairs about the middle and below.

Thorax gray pollinose with three to five dark vittae above. Chaetotaxy: acrostichal 0, 1; dorsocentral 3, 3; intraalar 2 (none near suture); supraalar 3; postalar 2; presutural 1 (outer); notopleural 4; humeral 3; sternopleural 3; scutellum with 2 lateral, 1 longish decussate apical and 1 discal pair well behind middle of disc; postnotal slope sparsely setose; propleuron bare.

Legs black; hind tibia sparsely villous; mid femur without comb and mid tibia with two long anterodorsal bristles; claws and pulvilli exceeding length of last tarsal segment.

Wing subhyaline, with a slight yellowish tinge basally and along costal margin; first posterior cell open far before wing tip; first vein bare, third setulose three-fourths the distance to small cross vein; costal spine short but distinct; epaulet black; calypter white.

Abdomen subshiny black, with rather thin gray pollen above in a tessellated pattern, the usual three dark vittae apparent but the lateral ones poorly defined; segments one and two without median marginals, three and four each with a marginal row; fifth sternite reddish black, with a broad U-shaped median excision, the lobes rather small, the extreme inner margin of each thickly beset with black bristly hairs.

Hypopygium moderately large, wholly shining; first segment black, with a row of weak bristly hairs on hind margin; second segment red, nearly as large as first and clothed with fine black hairs above; forceps blackish, the broad united basal part somewhat flattened behind and slightly grooved along median line about to narrowed middle, thence the forceps diverge in separate prongs; the latter nearly equibroad and gently bowed in profile with the apical extremity produced as a minute hook and bearing a dense vestiture of minute stubby spines on the lateral anterior margin; penis with a stoutish, moderately long basal stalk, which is translucent white on anterior margin; distal segment composed of two principal lobes curved forward from a common base in the form of an incomplete O; viewed from behind the larger posterior lobe is swollen at the base but decidedly compressed beyond and bears a triangular recurved tooth near middle; anterior lobe carinate on the front side and expanding laterally to a very thin margin, immediately above base of latter a pair of thin pale membranous structures extend forward and outward attaining a point about opposite the tip of lateral tooth on the posterior lobe; accessory process ovate, moderately tapered apically; posterior clasper short and inconspicuous, anterior one heavy, bowed forward from base, tip strongly emarginate.

Length: 10.5 mm. Female unknown.

Holotype: Great Smoky National Park, N.C., August 13, 1934.

The species belongs in Aldrich's group "B" and traces to *sarracinae*, from which it differs markedly in structural details of the genitalia.

***Sarcophaga sutilis*, n. sp.**

Male.—Very similar to the preceding species except as follows: Head decidedly blacker in ground color, with plumbeous pollen which shows a brighter grayish sheen on parafrontal and parafacial when viewed from above; front at vertex 0.16 and at antennal base 0.33 of head width; cheek one-fifth eye height; wing gray hyaline; third vein setulose about halfway to small cross vein; costal spine not developed; fourth abdominal segment red on narrow hind margin and marginal row on preceding segment interrupted on either side of the median margin pair; fifth sternite smaller, with a V-shaped apical excision, lobes beset with fine hairs on inner margin.

Hypopygium not large, wholly red; first segment slightly infuscated on lower lateral margin and lightly sprinkled with pale pollen above, bearing a marginal row of six bristly hairs; second segment shiny on entire upper surface, which bears a vestiture of fine black hairs; forceps united to apical third, flattened base behind reddish, moderately wide, tapering towards middle and thence equibroad to apex; viewed from the side the forcep is gently bowed forward on the distal third, which tapers gradually to a bluntly rounded tip; penis similar in general form but considerably smaller than in *epitheca*; basal stalk somewhat elongate and bowed, whitish on anterior side; distal segment divided into two clawlike processes extending forward from a united base and curved inward distally; the posterior process is strongly compressed beyond middle and terminates in a rounded pale membranous tip; anterior process shorter, divided apically into two flattened outwardly directed lobes, which are most prominent in rear view; accessory process reddish, ovate, rather small; anterior clasper bowed forward from base, latter slightly expanded on outer side, apex obliquely truncate; posterior clasper shorter, tapering distally and bearing two short hairs just before the rounded tip.

Length: 9 mm. Female unknown.

Holotype: Smith County, Texas, May 9, 1941 (H. J. Reinhard).

The species is perhaps most closely allied to *epitheca* and *sima* and traces to the latter in Aldrich's key to group "B". However, the genitalic features are quite distinctive in each of these forms.

***Sarcophaga statuta*, n. sp.**

Male.—Front at vertex 0.21 and at narrowest (before triangle) 0.16 of head width; parafrontal yellow to pale golden becoming brownish black near vertex; frontals about twelve with two diverging below antennal base; outer vertical slightly differentiated, orbitals absent; ocellars well developed; frontal vitta black, wider than parafrontal on entire length; antenna black, about four-fifths length of face, second segment well over one-half longer than third; arista moderately plumose on proximal half; parafacial pale yellow pollinose, with a row of hairs on outer margin, lower ones somewhat bristly; clypeus gray pollinose, epistoma rather prominent in profile; facial ridge beset with a few hairs and bristles next to vibrissa; latter a trifle above oral margin; cheek shining black, one-fourth eye height; proboscis short; palpus black; back of head moderately convex, with three rows of postocular cilia and pale hairs about the neck and below latter.

Thorax rather thinly gray pollinose but marked with the usual notal vittae; four post dorsocentral bristles; preacrostichals absent, prescutellar pair strong; three sternopleurals; scutellum normally with two lateral, one long decussate apical and one somewhat smaller discal pair shortly before apex; propleuron bare; postnotal slope sparsely setose.

Legs shiny black; mid femur without comb, its tibia moderately villous and bearing three anterodorsal bristles; hind tibia villous, the hairs long and rather

dense; yellow brown-tipped claws longer than apical tarsal segment; pulvilli enlarged, yellowish.

Wing subhyaline; costal spine vestigial; first vein bare, third haired less than halfway to small cross vein; first posterior cell open well before wing tip; epaulet black; calypter large, semitransparent, white.

Abdomen gray, tessellated, with three rather indistinct vittae above; basal segments without median marginal bristles, third with one pair and fourth bearing a complete marginal row; fifth sternite black, with a wide V-shaped excision, lobes rather small and largely retracted.

Hypopygium moderately large; first segment shining black with a reddish tinge in ground color especially on apical margin; second segment globose, shining red becoming brownish on sides below; accessory process reddish, rather short, about half as wide as long and broadly rounded on apex; forceps moderately long and slender in profile, gradually bowed forward on apical third and tapering to sharp tips, which in rear view are rather widely separated by a V-shaped excision; penis jointed near middle, basal segment swollen and translucent white in front, darker and chitinized on hind side with a distinct median groove; distal segment large, subtriangular in profile, the laterally margined convex hind part tapers irregularly to a vaselike tip, which bears a fringe of closely set pale hairs; near the anterior basal extremity the segment bears a pair of pale membranous lobes, flaplike on basal part from which a prolonged pointed finger like process on either side extends obliquely rearward; next beyond latter a pair of chitinized hooked plates reach distally about to middle of segment and immediately behind these is a pair of long rodlike structures that continue to and curve forward with the apex of the segment; anterior clasper black, rather strongly bowed, inner margin with a pale brown lobe or tooth before the flattened apex; posterior clasper simple, shorter, tapering to a rounded, slightly bowed tip.

Length: 12 mm. Female unknown.

Holotype: Skalkaho Pass, Hamilton, Montana, August 1, 1949 (R. H. Beamer) in the Snow Entomological Collections, Kansas University.

In genitalic features the present species seems most closely allied to *perspicax*, but there are well defined structural differences as noted above. The fore tibiae in *perspicax* are distinctly villous, which is not true in the present species.

***Sarcophaga perissa*, n. sp.**

Male.—Similar to the preceding species except as follows: Front at vertex 0.19 of head width and only a trifle narrower before triangle; parafrontal and parafacial gray pollinose; two sternopleural bristles; fore tibiae distinctly villous; forceps shorter, not so strongly bowed apically, with tips of prongs more closely approximated; apical segment of penis much smaller, hind side decidedly humped or swollen beyond middle, thence tapering distally to a minute tip which is cleft as viewed from the side, the lower or posterior process is largely covered behind by a pale membranous structure clothed with microscopic hairs; on the front side near middle the segment bears a pair of large subovate lobes which bear a rather deep fold near middle of the paler outer margin; anterior clasper rather slender, directed forward from base, inner margin slightly widened by an angulation near apical third, apex flattened and broadly rounded.

Length: 11-12 mm. Female unknown.

Holotype: Mt. Timpahopos, Utah, June 23, 1950 (G. F. Knowlton and G. E. Bohart). Paratype, 1 male, Providence, Utah, May 30, 1948 (W. J. Hanson).

The species is evidently allied to *elongata*, which I have not seen. The genitalia of the latter, as described and illustrated by Aldrich (Sarcophaga and Allies), differ rather decisively from the present species in the shape of the distal segment of the penis and in details of the anterior claspers.

***Sarcophaga hetaera*, n. sp.**

Male.—Front at vertex 0.27 of head width, narrowed to 0.23 of same below ocellar plate, thence widening rapidly into facial angle; parafrontal and parafacial silvery pollinose, former with a few short scattered hairs outside frontal row; median vitta blackish, not sharply defined on sides, about equal to parafrontal width; inner verticals moderately strong; frontals about nine in a single row, two beneath base of antennae; ocellar bristles well developed, proclinate; antenna black, second segment more or less reddish apically and a little less than one-half length of third; arista long plumose on basal three-fifths or more; parafacial one-half clypeal width, bearing a row of weak hairs on outer margin becoming longer but not bristlelike near lower corner of eye; vibrissae decussate, slightly above oral margin; facial ridge with weak hairs ascending nearly to middle; cheek slightly over one-fourth eye height, gray pollinose and clothed with black hairs; palpus black, moderately thickened at tip; haustellum short; back of head with three rows of postocular cilia and wholly pale-haired below.

Thorax gray pollinose with three to five dark vittae above; prescutellars well developed; preacrostichals hairlike; post dorsocentrals spaced for four, the anterior two bristles considerably smaller than posterior two; sternopleurals three; scutellum with two large lateral, one small decussate apical and one scarcely larger discal pair; propleuron bare; postnotal slope setose.

Legs moderately slender, black; hind tibia not villous; middle femur with comb and its tibia bearing one stoutish anterodorsal bristle; hind coxa haired posteriorly; claws and pulvilli exceeding length of apical tarsal segment.

Wing hyaline; first vein bare, third setulose about two thirds the distance to small cross vein; costal spine short but distinct; hind and apical cross veins strongly oblique and in same plane; latter reaching costa far before wing tip; calypter opaque, white; epaulet blackish.

Abdomen black, gray pollinose with three dark vittae above extending from base to tip in most angles of view; three basal segments without median marginals, fourth with a complete marginal row; fifth sternite reddish black, the lobes concave on ventral side and narrowly separated along the median incision, inner apical margin of each lobe terminating in a short rounded flap beset with minute stubby spines.

Hypopygium wholly red, surface moderately shiny; first segment with a marginal row of ten to twelve stoutish bristles and second beset with fine black hairs above; united base of forceps reddish, very prominent in profile and sloping forward with a distinct notch at base of free part of forceps; latter brownish black, thin in profile and strongly bowed forward from middle to a sharply pointed tip; viewed from behind each forcep is triangular, with the broadish base smooth and highly polished, beyond which the median part bears a dense vestiture of stubby rasplike spines; accessory process reddish yellow, tapering apically to a narrow tip which bears several black bristly hairs; penis rather compact in structure, the moderately swollen distal portion bowed forward at the apex, which bears a pair of black strongly curved, densely spinose lobes; basad of latter the penis bears a much thicker and less conspicuously spinose anterior lobe directed down and rearward; anterior clasper short, with a moder-

ately broad triangular base, tip narrow, strongly bowed anteriorly; posterior clasper considerably longer and gently curved forward from base to tip.

Length: 8.5-9 mm. Female unknown.

Holotype: Big Bend Park, Hot Springs, Texas, April 11, 1949 (Michener-Beamer) in the Snow Entomological Collections, Kansas University. Paratype: 1 male, "15 mi. S. E. Langtry, Texas, April 13, 1949, Michener-Beamer".

The species belongs to Aldrich's group "H" but does not appear closely allied to any of the species included here. In form and vestiture, the forceps are somewhat similar to the corresponding parts of *beameri*, but in other details the genitalia differ widely. Also, the latter species has villous hind tibiae.

Efficiency of Grasshopper Baits in Relation to Time of Day of Application[1]

By R. H. HANDFORD[2] AND L. G. PUTNAM[3]

Introduction

Literature on grasshopper control published between 1930 and 1942 stressed the desirability of applying poisoned bait when grasshoppers begin their first main feeding period of the day. Such publications include those by Parker (1930), Parker, Walton, and Shotwell (1932), Criddle (1932), Ruggles and Aamodt (1938), and Bird (1940). Parker (1930) found that the lesser migratory grasshopper, *Melanoplus mexicanus mexicanus* (Sauss.), fed sparingly on baits at air temperatures between 55°F. and 63°F., more actively between 64°F. and 67°F., and most actively between 68°F. and 78°F. A rapid decrease in feeding occurred when air temperature rose above 80°F. or the soil surface temperature above 113°F. Much the same relationship held also for the clear-winged grasshopper, *Camnula pellucida* (Scudd.). On the basis of such observations it was decided that an air temperature of 68°F. might be classed as optimum for beginning the application of bait. Parker did not, however, indicate the degree of mortality resulting from such feeding; the other writers gave no experimental data.

Before 1930 it had been customary to apply bait during the early morning without waiting for a definite temperature. Moreover, even during the period 1930 to 1942, the authors had received many verbal reports of successful results from such early-morning baiting. The experiments described below were designed to provide a reasonably conclusive answer to the controversial point. On the basis of the results obtained, the statement that baiting should not be begun until the air temperature in the shade reached 68°F. was withdrawn in 1944 from Canadian recommendations for grasshopper control.

The experiments were conducted in a different locality each year for three consecutive summer seasons, 1942-44, under a variety of conditions. The main treatments were repeated 30 times in all.

Comparisons were made of the following hours of application, details of which are given in Table IV:—

late evening (1942 and 1943 tests only);

early morning (all tests);

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"optimum" conditions, i.e., when the air temperature in the shade first reached 68°F. (all tests);
afternoon (all tests).

M. m. mexicanus (Sauss.) was the predominant species throughout the tests.

Methods and Materials

The methods described by Ford and Larrimer (1921) and by Hinman (1939) were used with minor modifications in all the tests.

The standard plot size was one-fifth of an acre. Treatments and checks were randomized and appeared once in each block. Only two blocks, i.e., two replications of each treatment, could be handled in any one period of 24 hours; each pair of such blocks is referred to as a series.

Bait was applied by means of a spoon-shaped wooden paddle designed (but not previously described) by Mr. Stuart Criddle of Treesbank, Manitoba. Shingle nails inserted vertically around the enlarged end of the paddle at one-quarter-inch intervals improved the capacity and design of the paddle, making it possible for a worker to spread the measured quantity of bait uniformly over each plot. Quantities of bait were based on the volume of two pounds of dry bran per plot (10 pounds of dry bran per acre). The formula used in 1942 was as follows:—

Sawdust	4 imperial quarts less ⅓ fl. oz.
Flour (second grade)	12⅓ fl. oz.
Sodium arsenite	0.8 fl. oz. (7.7 lb. of As_2O_3 per imperial gallon)
Water	32 fl. oz.

The ratio of poison to dry carrier in the above formula is equal to 1.92 pounds of As_2O_3 in a bulk of carrier equal to 100 pounds of bran. In 1943, on the basis of experimental results not yet published, the flour was reduced from one-fourteenth to one twenty-eighth of the volume of total carrier. In 1944 the flour again formed one twenty-eighth of the volume of the carrier, but sodium fluosilicate (36.3 grams, or four pounds in a volume of carrier equal to 100 pounds of bran) was substituted for sodium arsenite.

After a feeding period lasting from 1½ hours in some instances to three hours in others, two collections of approximately 100 grasshoppers each were taken from each plot. This required four to eight minutes, depending upon the population present. Each collection was then placed in a small cage measuring six by six by 12 inches; the sides consisted of wire screening and the tops and bottoms of wood. To prevent excessively high temperatures, the cages and their contents were kept away from direct sunlight. The grasshoppers were fed fresh dandelion or wheat leaves three or four times daily. At the end of 72 hours mortality was sufficiently complete to enable counts to be made. These methods are based upon the relatively slow action of the arsenicals and fluosilicates in grasshoppers.

Every effort was made to eliminate variables other than treatments within any one series. The experimental area for a series was selected to give maximum uniformity of vegetation, soils, and grasshopper populations from plot to plot, but there was considerable variation from one series to another. Baits for any one block were spread by the same worker. The two grasshopper collections were made by two men, each man taking a sample from every plot in a block. Plots were sampled in the same order as bait was applied, with the sampling time-intervals the same as baiting time-intervals.

The experiments were designed to compare the effects of bait spread in the evening after grasshopper activity had ceased, and in the morning before activity

was resumed, with those of bait spread during the active or "optimum" feeding period. Hence a compromise had to be reached concerning the interval between application of bait and collection of grasshoppers. Experiments and observations had shown (1) that very few grasshoppers were killed during extended periods of low temperatures and (2) that differences in percentage mortality from exposure of grasshoppers to baits for periods of 1½ and 2½ hours, although statistically significant, were very small even when bait was applied during the most active feeding period of the day. In 1942, in 120 plots, the average difference, in favour of the longer exposure period, was only 4.9 per cent. In 1943, in 130 plots, the difference between exposures of 1½ and three hours was only 4.03 per cent. On the basis of these observations it was decided that the most reliable comparison would result from the delaying of collections from the evening and early-morning treatments until immediately before collections were made from the "optimum" plots. Collections from plots treated during the active period of the day were made after exposures of 1½, 2½, or three hours as conditions demanded.

Two collections were made from each check plot in 1942 and 1943. The first of these was made at the same time as collections from the plots treated at the time of "optimum" conditions, the second at the same time as collections from plots baited during the afternoon. They are labelled "first check" and "second check", respectively, in Tables V and VI. The single check collection listed in Table VII was made immediately after those taken from the plots baited under the so-called optimum conditions.

Grasshopper Species and Developmental Stages

The lesser migratory grasshopper, *Melanoplus mexicanus mexicanus* (Sauss.), formed the bulk of the grasshopper population at Davidson, Sask., in 1942. When the experiments were begun on July 25, second-, third-, fourth-, and fifth-instar nymphs were present, with the fourth and fifth stages predominant and equal in abundance. When the tests were completed on August 4, fifth-instar nymphs predominated, and about 15 per cent of the population was in the adult stage.

At Piapot, Sask., in 1943, *M. m. mexicanus* made up 72 per cent of the population on the average, and the Packard grasshopper, *M. packardii* Scudd., 18 per cent. However, the latter species slightly exceeded the former in series 1. The remaining 10 per cent consisted of a variety of species, including a small number of the two-striped grasshopper, *M. bivittatus* (Say), and an occasional clear-winged grasshopper, *Camnula pellucida* (Scudd.). Fourth- and fifth-instar *M. mexicanus* were predominant in series 1 and 2 and fifth-instar nymphs and adults in series 3; adults comprised 60 per cent of the *M. m. mexicanus* specimens collected from series 4 and 5. The population of *M. packardii* was a little more advanced in development than that of *M. mexicanus*.

Of the experiments at Taber, Alberta, in 1944, records of species and their development are available for only series 1 to 4. *M. m. mexicanus* comprised 96 per cent of the recorded population. Of these, fourth- and fifth-instar nymphs were predominant in series 1 and 2; fifth-instar nymphs and adults, in series 3 and 4.

Experimental Conditions

Soil—The 1942 experiments were performed in an area of sandy loam soil near Davidson, Sask., and those of 1943 in fine sandy loam near Piapot, Sask. At Taber, Alta., in 1944, the soil was a silty loam in all plots except those of series 1; in these instances fine sandy loam again prevailed.

Vegetation.—Although the same crops and weeds were present to a greater or lesser extent in the three areas, there were some notable differences. In 1942, series 1 of each treatment was located in rather sparse, headed, fall rye, the next two series in untilled stubble with the usual sparse growth of weeds, and the last series in a field of spring wheat. In 1943 the plots of series 1 were located in untilled stubble with a moderate growth of tumbling mustard, *Sisymbrium altissimum* L., lamb's quarters, *Chenopodium* sp., probably *album* L., Russian thistle, *Salsola pestifer* Nels., and other weeds. Series 2 and 3 were placed in a thin stand of spring wheat 12 to 18 inches in height with a moderate undergrowth of Russian thistle two to three inches high. Series 4 and 5 were in an oat crop that had been generally thinned by the grasshoppers but was still a moderately good stand with fairly dense basal leaf growth that had matured and turned brown; Russian thistle again formed a light undergrowth. In 1944, series 1 was in spring wheat containing some Russian thistle, series 5 in a thin stand of flax (12 to 18 inches high) and Russian thistle. The remainder were in weedy, untilled stubble of the preceding season's crop; tumbling mustard eight to ten inches high was uniformly distributed over series 4 and 5; Russian thistle was predominant and uniformly distributed over series 2 and 3, with some tumbling mustard also present.

The vegetation is compared in Table I.

TABLE I
TYPE OF VEGETATION IN EACH SERIES OF PLOTS, SASKATCHEWAN AND ALBERTA, 1942–44.

Series	Davidson, Sask., 1942	Piapot, Sask., 1943	Taber, Alta., 1944
1	Fall rye	Stubble and weeds	Spring wheat
2 & 3	Stubble and weeds	Spring wheat	Stubble and weeds
4	Spring wheat	Oats	Stubble and weeds
5		Oats	Stubble and weeds
6			Flax

Temperature.—Meteorological conditions varied considerably. The 1942 season was backward and cool, the 1943 and 1944 seasons considerably warmer. In 1942, early-morning applications of bait were made at temperatures as low as 40°F. Maximum air temperatures, recorded at the site at the time of baiting and collecting, reached at least 70°F. during every day on which experiments were conducted, but the highest record was only 75°. A complete series of soil surface temperatures was not taken, but during the heat of the day it was noted that they sometimes exceeded air temperatures by as much as 28 degrees Fahrenheit.

The lowest temperature recorded for the early-morning application of bait in 1943 was 51°F. The daily maxima during the tests ranged from 82° to 93°F. As usual, early-morning soil surface temperatures approximated the air temperatures, the lowest being 53°F.; during the heat of the day the soil surface reached as high as 135°F., exceeding the air temperature by 52 degrees Fahrenheit.

In 1944, air temperatures ranged from 44° to 62°F. at the time the early-morning tests were begun, rising to a range of 76° to 93°F. during the heat of

the day. The corresponding soil surface temperatures were 50° to 58° to 130°F. During the early-morning treatment of series 4 the soil surface temperature was four degrees below the air temperature; in all other early-morning periods it was equal to or slightly higher than the air temperature.

These temperatures, in part, are compared in Table II.

TABLE II

AIR AND SOIL TEMPERATURES RANGE (°F.) EARLY IN THE MORNING AND AT THE HEAT OF THE DAY ON DAYS OF BAIT APPLICATION, SASKATCHEWAN AND ALBERTA, 1942–44.

Place and Year	Davidson, Sask. 1942	Piapot, Sask. 1943	Taber, Alta. 1944
Air minima, early a.m.	40 to —	51 to —	44 to 62
Air maxima, heat of day	70 to 76	82 to 93	76 to 93
Soil surface minima, early a.m.	—	53 to —	50 to 58
Soil surface maxima, heat of day	air temp. +28	— to 135	79 to 130

Cloudiness, precipitation, humidity, and wind.—Sunshine exceeded cloudiness throughout most of the 1942 series, the reverse being true for series 4 only. No rain fell on any of the bait, but the soil was moist during the early part of the day on which series 2 was treated. There was dew on the vegetation each morning of each test period. Relative humidity reached as high as 79 per cent during evening and early-morning treatments but fell back into the range 35.5 to 57 per cent during the warm period of the day. On one occasion wind reached 15 to 20 miles per hour during experimental activities but ranged usually from two to four miles per hour.

In 1943 a maximum of 80 per cent cloudiness was reached for series 1 and of 60 per cent for part of the day when series 5 was treated; only a few scattered clouds were present for each of the other three series. Light rain fell on the day preceding that on which series 4 was treated, but the soil was dry by the time treatment was begun, as for all the other series of that year. There was light dew also in the early morning of the day series 4 was treated but none at any other time during the tests. Relative humidity ranged from 64 to 90.5 per cent during the early-morning applications in 1943, but dropped into the range 16.5 to 32 per cent during the heat of the day.

At Taber, in 1944, cloudiness ranged from nearly 100 per cent on the day for series 1 to very nearly zero for series 5. There was no rain to interfere with the tests, the soil surface being dry from the beginning to the end for each series. No dew was recorded at any time. Wind was light for series 5 and 6, but reached 20 miles per hour when some of the plots of series 1 were being treated; it reached 10 miles per hour at least once during each day the other series were being treated. The dry morning conditions were reflected in relative humidity ranges of 52 to 80 per cent during the heat of the day.

Dates and hours of application.—The dates on which the various series of plots received bait are given in Table III. Where two dates are given for a series, the first is that on which late-evening baiting was done.

Details of the hours of bait application are given in Table IV. During the cool season of 1942, optimum air temperature (68°F.) was not always reached during the morning. On two days, July 31 and August 2, applications for the

TABLE III
DATES ON WHICH BAITS WERE APPLIED, SASKATCHEWAN AND ALBERTA, 1942–44.

Series	Davidson, Sask., 1942	Piapot, Sask., 1943	Taber, Alta., 1944
1	July 25 & 26	July 8 & 9	June 24
2	July 30 & 31	July 17 & 18	June 28
3	Aug. 1 & 2	July 19 & 20	July 15
4	Aug. 3 & 4	July 24 & 25	July 16
5		July 26 & 27	July 18
6			Aug. 2

TABLE IV
EARLIEST AND LATEST HOURS THAT BAIT WAS APPLIED DURING THE VARIOUS BAITING PERIODS, SASKATCHEWAN AND ALBERTA, 1942–44.

Time of Treatment	Davidson, Sask., 1942 Earliest	Latest	Piapot, Sask., 1943 Earliest	Latest	Taber, Alta., 1944 Earliest	Latest
Evening	8.55 p.m.	9.22 p.m.	6.59 p.m.	7.17 p.m.		
Earling morning	6.10 a.m.	6.35 a.m.	3.54 a.m.	4.09 a.m.	5.00 a.m.	5.20 a.m.
"Optimum"	10.15 a.m.	3.30 p.m.	6.20 a.m.	8.39 a.m.	9.20 a.m.	10.08 a.m.
Afternoon	2.15 p.m.	6.00 p.m.	12.45 p.m.	1.20 p.m.		
"Optimum"+2 hr.					11.20 a.m.	12.08 p.m.
"Optimum"+ 4 hr					1.20 p.m.	2.08 p.m.
"Optimum"+ 6 hr.					3.20 p.m.	4.08 p.m.

optimum period were not made until afternoon, the latest being at 3.30 p.m. This caused a delay also in the corresponding afternoon applications.

Results and Discussion

The percentages of grasshopper mortality resulting from the various treatments are given in Tables V, VI, and VII.

The tables show that the average mortality from evening and early-morning baiting was at least as high as that obtained by applying bait when the temperature in the shade first reached 68°F. Further, the results from afternoon baiting are lowest, significantly lower than those from early-morning baiting in 1942 and 1944, though not significantly lower than those from applications at the "optimum" period (difference necessary for significance at the 5 per cent level in 1944, 7.6; difference obtained, 7.4).

When the results for the early morning, the "optimum" period, and the afternoon (four hours after "optimum" time was used as the afternoon period in 1944) for the three years are considered together, the differences for the early morning and the afternoon from the "optimum" are significant as follows:—

Baiting Period	Average mortality in 30 replicates per cent	Level of significance
Early morning	53.0	7 per cent
"Optimum"	48.5	
Afternoon	43.3	5 per cent
Difference necessary for significance at 5 per cent level	4.64	

When warm, sunny weather occurs during the day that bait is applied, early-morning baiting, and probably evening baiting, can be expected in most instances to give results at least as satisfactory as those obtained from bait applied when the air temperature in the shade first reaches 68°F. A reasonable measure of control is often secured from afternoon baiting.

The very poor results from series 4 and 5 at Piapot (Table VI) appear to have been due to the nature of the vegetation. The vegetation has already been

TABLE V.

PERCENTAGE MORTALITIES OF GRASSHOPPERS AFTER APPLICATIONS OF POISONED BAIT AT VARIOUS TIMES OF DAY, DAVIDSON, SASK., 1942.

Time of Treatment	Series 1	Series 2	Series 3	Series 4	Average[1]
	(averages for duplicate plots)				
Evening	64.2	72.2	85.2	60.5	70.5
Early morning	55.6	76.4	81.3	65.6	69.8
"Optimum"	63.3	66.7	78.0	43.7	62.9
Afternoon	50.4	49.3	73.8	50.7	56.1
Average	58.3	66.2	79.5	55.1	64.8
First check[2]	2.9	11.9	5.3	5.1	6.3
Second check[3]	1.1	11.4	6.2	2.2	5.2

1. Difference necessary for significance at 5 per cent level; 10.4; check plots not considered. 13 6
2. Collections made at the same time as in the plots that had been treated at the "optimum" time.
3. Collections made at the same time as in the "afternoon" plots.

TABLE VI

PERCENTAGE MORTALITIES OF GRASSHOPPERS AFTER APPLICATIONS OF POISONED BAIT AT VARIOUS TIMES OF DAY, PIAPOT, SASK., 1943.

Time of Treatment	Series 1	Series 2	Series 3	Series 4	Series 5	Average[1]
	(averages for duplicate plots)					
Evening	55.5	64.9	66.5	13.9	10.1	42.2
Early morning	56.0	62.0	69.0	10.3	12.9	41.9
"Optimum"	49.9	64.2	66.2	13.1	12.4	41.2
Afternoon	60.4	61.0	53.8	11.2	12.1	39.7
Average	55.5	63.1	63.8	12.2	11.9	41.3
First check[2]	8.9	.6	1.6	1.1	.5	2.4
Second check[3]	2.9	.9	1.4	3.8	2.6	2.4

1. Difference necessary for significance at 5 per cent level (check plots not considered), 5.38.
2. Collections made at the same time as in the plots that had been treated at the "optimum" time.
3. Collections made at the same time as in the "afternoon" plots.

TABLE VII

PERCENTAGE MORTALITIES OF GRASSHOPPERS AFTER APPLICATIONS OF POISONED BAIT AT VARIOUS TIMES OF DAY, TABER, ALTA., 1944.

Time of Treatment	Series 1	Series 2	Series 3	Series 4	Series 5	Series 6	Average[1]
	(averages for duplicate plots)						
Early morning.....	43.1	51.0	64.8	53.6	47.6	45.6	50.5
"Optimum".....	41.4	51.6	60.3	44.1	26.9	36.4	45.1
"Optimum"+2 hr...	47.7	54.3	65.9	33.7	23.7	39.8	44.2
"Optimum"+4 hr...	44.9	50.1	52.9	28.6	15.9	43.2	37.7
"Optimum"+6 hr...	48.9	31.2	55.0	23.8	8.9	33.1	33.4
Average.....	46.2	45.6	59.8	36.7	25.6	39.7	42.2
Check[2].....	10.5	.1	0.9	9.4	4.7	3.8	4.9

1. Difference necessary for significance at 5 per cent level (check plot not considered). 7.6.
2. The check collections were made immediately following those from plots baited under "optimum" conditions

described in the section "Experimental Conditions". The lower mortalities for series 4 and 5 at Taber in 1944 are less easily explained. Vegetation in the plots of these series was no more dense than in the others, nor was there greater wind or humidity. The only marked difference was in the degree of cloudiness and the temperature of the soil surface. Clouds were few to none for both series, and soil temperatures rose correspondingly. Soil temperature maxima of 126°F. for series 4 and 130°F. for series 5 were reached during the afternoon baiting periods. The next highest was 112°F., for series 2. Parker (1930) states that *M. m. mexicanus* begins climbing vegetation to escape heat at an average soil surface temperature of 112.6°F. The data in Table VII suggest that the very low daily average mortalities for series 4 and 5 were due primarily to the poor results obtained during afternoon baiting periods when temperatures were at their peak.

Summary and Conclusions

Results from early-morning applications of poisoned bait (an average of 53.0 per cent mortality for three seasons) were significantly higher at the seven per cent level than those (48.5 per cent) from bait applied when the air temperature first reached 68°F. in the shade. The results from both these applications were significantly higher at the five per cent level than those (43.3 per cent) for baits applied during the afternoon. Evening treatments, applied during 1942 and 1943 only (18 replications), were equal to or better than treatments applied early in the morning or at the "optimum" time in both years, and averaged 54.8 per cent mortality.

There is evidence that mortality due to baiting varied inversely as the density of the vegetation and, on hot days at least, inversely also as the soil surface temperature.

The experiments were carried out at Davidson, Sask., 1942; Piapot, Sask., 1943; and Taber, Alta., 1944.

The early-morning, "optimum", and afternoon treatments were replicated 30 times under a variety of vegetational and meteorological conditions; the evening and extra afternoon treatments were not included in every test.

Melanoplus mexicanus mexicanus (Sauss.), in late-nymphal and early-adult stages, was the main species involved in all the tests.

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Book Review

***Field Crop Insects*, by F. A. Fenton. The Macmillan Co. Price $5.75 in Canada.**

This is an excellent general text book on insects attacking field crops. It is perhaps unfortunate, from the standpoint of Canadian readers, that the insects and crops chosen to illustrate the various points the author wishes to make are primarily southern species unfamiliar to Canadian students. However, this does not seriously detract from the value of the book as a text or reference. If one is looking for principles, this book is excellent but if he wishes to identify field crop pests that might be encountered in Canada, he will be disappointed.

The first ten chapters deal entirely with basic principles for the study of the biology and control of insects, although the illustrative examples are insects affecting field and vegetable crops. This portion of the book is an excellent general reference, containing information on insect abundance and distribution, insect biology, insecticides and methods of application, cultural, mechanical, and biological control.

The last seven chapters deal with specific species, classified according to the portions of the plant on which they feed. It is not intended that this should be an encyclopedia of insects affecting field and vegetable crops, but rather a wide selection of species to illustrate types of insects, damage, seasonal histories and control practices.

H. L. SEAMANS

Mr. J. J. de Gryse

J. J. de Gryse, Chief, Division of Forest Biology, Science Service, Department of Agriculture, Ottawa, retired on May 11 after 29 years' service. A graduate of Louvain University, Belgium, specializing in the morphology of Lepidopterous larvae, and at one time on the staff of the Bureau of Entomology, United States Department of Agriculture, Washington, Mr. de Gryse joined the Canada Department of Agriculture on August 14, 1923, as an Assistant Entomologist and was stationed at the Forest Insect Laboratory, Indian Head, Saskatchewan.

In 1925, he was transferred to Ottawa, in 1936 made Chief of the Division of Forest Insects, and in 1951 appointed Chief of the recently organized Division of Forest Biology. Because of his broad experience, Mr. de Gryse was prevailed upon to continue his duties beyond the normal retirement age.

The rapid expansion of the scientific staff and facilities and the initiation of a sound research program in the Division of Forest Biology is directly attributable to the energy and foresight of Mr. de Gryse. The Division has developed one of the strongest units in the study of insect diseases and already the modern Laboratory of Insect Pathology, opened in May, 1950, at Sault Ste. Marie, Ont., has made a notable contribution through its virus spray investigations. The job of co-ordinating the many phases of research in the Division has been difficult and exacting and the measure of success attained to date is a direct tribute to him. Also worthy of mention is the fact that Mr. de Gryse is a Fellow of the Royal Society of Canada—an honour conferred upon him in 1941 in recognition of his valuable contributions to Science.

C. H. Kenny

Dr. Malcolm L. Prebble

Dr. Malcolm L. Prebble has been appointed Chief of the Division of Forest Biology, Science Service, Department of Agriculture, Ottawa, succeeding Mr. J. J. de Gryse.

Dr. Prebble, until his new appointment, has been Officer-in-Charge of the Forest Biology Laboratories at Sault Ste. Marie, Ont. A native of Saint John, N.B., he joined the Forest Insect Laboratory of the Department at Fredericton, N.B., in 1928. He received his B.Sc. degree in Forestry from the University of New Brunswick in Fredericton in 1930, and his M.Sc. and Ph.D. degrees from McGill University in 1932 and 1940 respectively. Dr. Prebble was attached to the Fredericton laboratory until 1940 when he was transferred to the Forest Insect Laboratory in Victoria, B.C. In 1945, he was appointed Officer-in-Charge of the Forest Insect Laboratory at Sault Ste. Marie.

Dr. Prebble is noted for his special studies on the European spruce sawfly and other insect pests common to Canadian forests.

C. H. Kenny

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